LEOPARD DARTER

Percina pantherina (Moore and Reeves)

REVISED RECOVERY PLAN
(Original Approved: September 20, 1984)

Prepared by

Paul W. James
Department of Biological Sciences
Central Washington University
Ellensburg, Washington

and

Kenneth D. Collins
U. S. Fish and Wildlife Service
Ecological Services
Tulsa, Oklahoma

for

Region 2
U.S. Fish and Wildlife Service,
Albuquerque, New Mexico

Date: 5/13/93

Disclaimer

Recovery Plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State Agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved Recovery Plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature Citation should read as follows:

U.S. Fish and Wildlife Service. 199___. Leopard Darter Percina pantherina (Moore and Reeves) Revised Recovery Plan. Albuquerque, New Mexico. ___ pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service:

5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301/492-6403 or 1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

EXECUTIVE SUMMARY

Current Species Status: This species is listed as threatened. Populations are presumed to be stable and are known from the Little, Mountain Fork, Glover, Robinson Fork, and Cossatot Rivers in southeastern Oklahoma and southwestern Arkansas. The leopard darter is particularly vulnerable to threats due to its restricted and fragmented distribution, low numbers, and low recruitment.

Habitat Requirements and Limiting Factors: The leopard darter inhabits pools and riffles in large to intermediate streams having relatively steep gradients with rubble, boulder, and bedrock substrates. Principal threats include habitat loss and degradation. The leopard darter is particularly vulnerable to impoundments and reservoir releases, alteration of spawning and rearing habitat, pesticide applications, and any other activity that adversely modifies essential habitat.

Recovery Objective: Delisting.

Recovery Criteria: Short-term recovery of the leopard darter requires the elimination or minimization of existing threats, specifically deauthorization of the proposed Reservoir on the Glover River and protection of remaining free-flowing stream segments within the Little River drainage in Oklahoma and Arkansas. Full recovery of the leopard darter requires preservation of genetic diversity thereby maximizing long-term evolutionary potential to ensure the continued existence of the species in a natural, self-sustaining environment.

Actions Needed:

1. Eliminate major threats, protect areas of existing habitat, and maintain the maximum number of populations within that habitat.
2. Determine, and where possible, improve the status of the species.
3. Determine and maintain genetic diversity and minimum viable populations
4. Disseminate information on the plight of this species.
5. Restore lost or enhance degraded habitats and re-establish extirpated populations.
6. Prepare and implement a monitoring plan.

Total Estimated Cost of Recovery (000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
FY94	123	37	5	30	57		252
FY95	167	39	5	28	59		298
FY96	160	32	11	2	64		269
FY97	94	6	10		29		139
FY98	47	6			29	7	89
FY99	23	6			21	1	51
FY00	23	6			21	1	51
FY01	17	6			21	1	45
FY02	17	6			21	1	45
FY03	17	6			21	1	45
Total Cost of Recovery	688	150	31	60	343	12	1284

Date of Recovery: Delisting should be initiated in 2003, if criteria are met.

RECOVERY PLAN OUTLINE

List of Figures

I. INTRODUCTION

Description

The leopard darter, Percina pantherina, is a small, percid fish endemic to streams in the Little River drainage of Oklahoma and Arkansas (Miller and Robison 1973). Prior to 1977, only 165 leopard darter specimens were reported collected or captured (Robison 1978). Several researchers and collectors recommended that the leopard darter be given special protection due to the species rarity and restricted distribution (Miller and Robison 1973, Buchanan 1974, Cloutman and Olmsted 1974, Robison et al. 1974, Hubbs and Pigg 1976). In 1978, the U.S. Fish and Wildlife Service listed the leopard darter as threatened and designated critical habitat in the upper Little River, Glover River, and the upper Mountain Fork River (43(19) FR:3711-3716; Fig. 1).

O. P. Hay collected the first leopard darters in 1884, but these specimens were not recognized as being P. pantherina until about 1970. In 1927, a single specimen from the Mountain Fork River in Arkansas was identified by Hubbs and Ortenburger (1929) as an aberrant Hadropterus macrocephalus. This specimen had the cheek scalation and body coloration now recognized as defining P. pantherina. As more collections were made in the Little River drainage of Oklahoma and Arkansas, it became apparent that a new species of darter occupied these areas. The species was formally described as Hadropterus pantherinus by Moore and Reeves (1955). Bailey et al. (1954) synonymized Hadropterus with Percina, and thus assigned the name Percina pantherina to the leopard darter.

The leopard darter most closely resembles the blackside darter, P. maculata. The leopard darter is distinguished from the blackside darter by having a row of 11-14 round black spots along the lateral sides, whereas the lateral blotches of blackside darters are fewer than 10 and

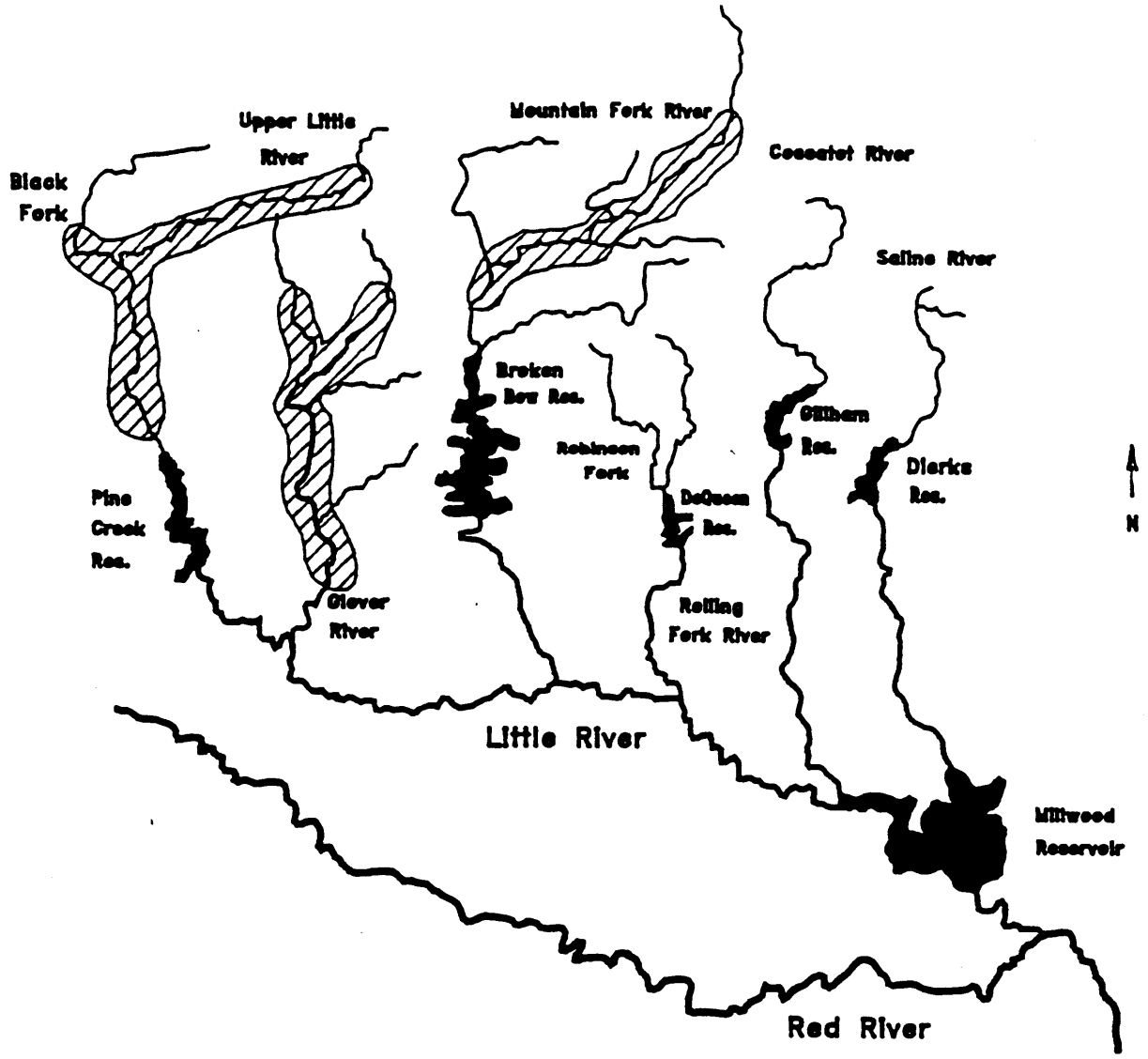

Figure 1. Little River drainage showing official critical habitat for the leopard darter.

tend to be longer than they are deep. Maximum size of the leopard darter is approximately 80 mm standard length. Excellent photographs and a detailed morphological description of the leopard darter can be found in Page (1983) and Kuehne and Barbour (1983).

Distribution and Abundance

Leopard darters presently occupy portions of the Little River upstream from Pine Creek Reservoir, Glover River upstream from Oklahoma Highway 3 and 7 bridge, Mountain Fork River upstream from Broken Bow Reservoir, Robinson Fork River upstream from its confluence with Rolling Fork River, and Cossatot River upstream from Gillham Reservoir (Fig. 2). Populations have also been found in some of the larger tributaries of these rivers. The downstream limits of leopard darter distribution can be clearly defined in all of these rivers, except the Glover, as the free-flowing area immediately upstream from reservoir headwaters. The entire distribution of leopard darter populations is confined to LeFlore, McCurtain, and Pushmataha Counties in Oklahoma and Howard and Polk Counties in Arkansas.

Historically, leopard darters also inhabited the lower Mountain Fork and Cossatot Rivers (Eley et al. 1975). These populations were extirpated following construction of Broken Bow and Gillham Reservoirs, respectively. Sections of the Little River in the area now impounded by Pine Creek Reservoir may also have historically supported leopard darters.

Leopard darters have never been collected from reservoirs and no reservoir could support a self-sustaining population primarily because suitable spawning habitat is absent. Three leopard darters have been collected below impoundments, one below Pine Creek Reservoir located on the Little River in Oklahoma and two below Gillham Reservoir on the Cossatot River in Arkansas. One specimen was collected below Gillham Reservoir in 1976 (Robison 1978). A single specimen

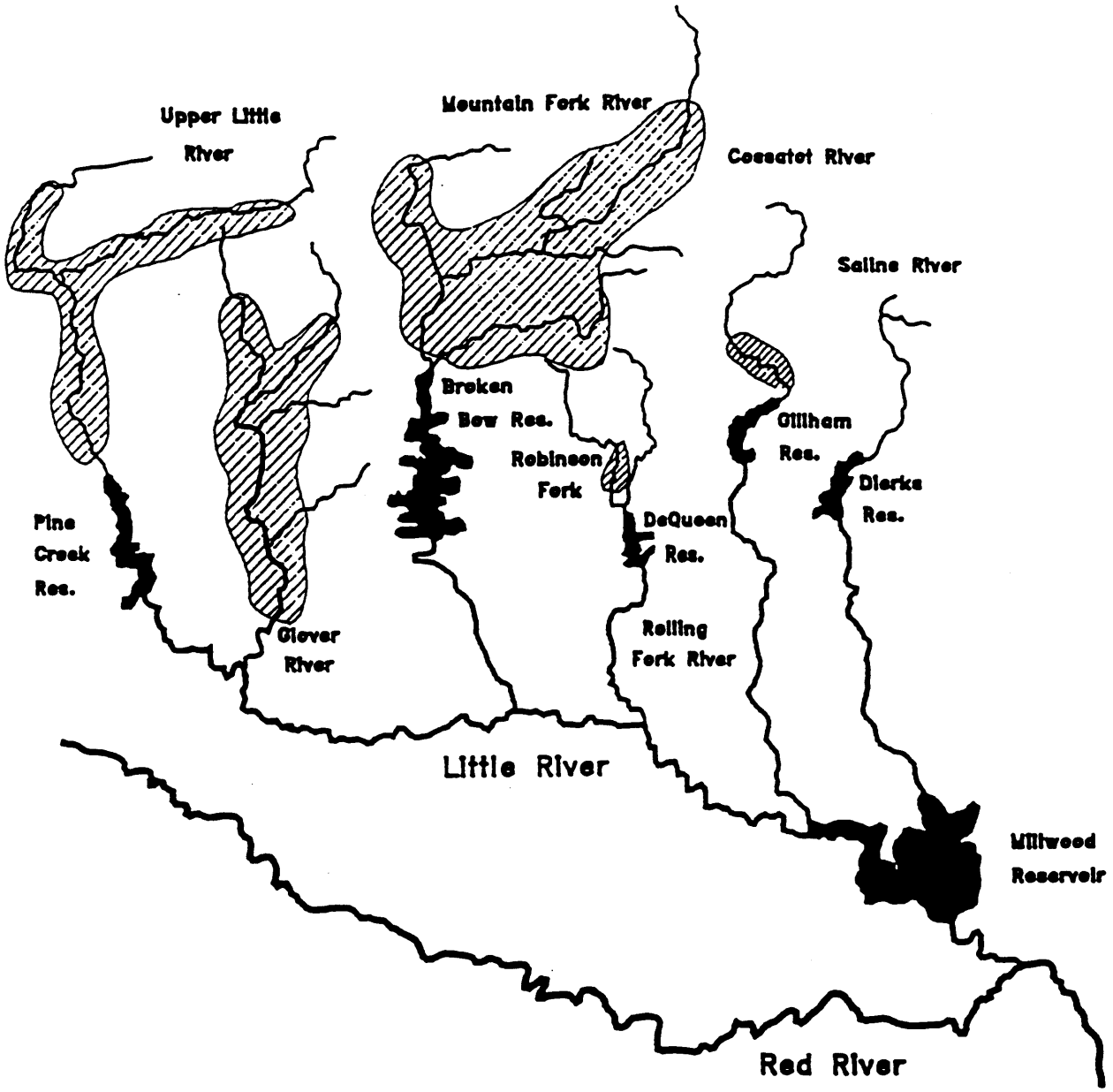

Figure 2. Present Distribution of Leopard Darters Within the Little River Drainage.

was collected below each impoundment in 1979 by U.S. Fish and Wildlife Service personnel stationed at the National Reservoir Research Program office in Arkadelphia, Arkansas. Leopard darters have not been collected downstream of an impoundment since 1979 and no leopard darter populations currently exist below any major impoundment within the Little River Basin. Reservoir releases are believed to impact leopard darters by altering the quantity and quality of downstream flows (Eley et al. 1975).

Prior to 1985, 125 separate collecting attempts from approximately 56 different localities resulted in collection or capture of only 333 leopard darters: 31 from 10 locations within the upper Little River drainage, 197 from 25 locations in the Glover River drainage, 48 from 13 locations in the Mountain Fork River drainage, and 57 from 8 locations in the Cossatot River.

Collections made since 1985 by Lechner et al. (1987) throughout the upper Mountain Fork and upper Little River drainages revealed the presence of leopard darters at 42 of 147 sites. A total of 84 adults and 132 juveniles were observed. The largest numbers of leopard darters were found in the main channels of the Mountain Fork and Little rivers. Corresponding observations made by Leon et al. (1987) in the Rolling Fork, Cossatot, and Saline river systems revealed the presence of leopard darters at only 5 of 40 sites. A total of 29 individuals was observed. These observations confirmed and extended the known distribution of the leopard darter in the Cossatot River, and revealed the existence of a previously unknown population in the Robinson Fork River. No leopard darters were found in the Saline River basin. During the period from 1985-88, James (1989) captured 835 individuals from the Glover River upstream of the confluence of Carter Creek. Recapture observations were not recorded during this investigation and the number of individuals captured is not indicative of the total size of the existing population(s).

Leopard darter populations in the Cossatot and Robinson Fork rivers are small and confined to discrete stream segments (Leon et al. 1987). Estimates of leopard darter population

densities for the Cossatot River, based on observations at one locality, varied from 0.016 to 0.072 individuals/square meter (m^2) (Jones et al. 1984). Leon et al. (1987) found leopard darter densities in the Cossatot River varied according to observed values for depth, substrate, and water velocity. Reported values varied from 0.0024 to 0.0333 individuals/m^2. The combined data included 23 individuals and 4,815 m^2 of habitat for an overall density of 0.0048 individuals/m^2.

Populations in the Mountain Fork, Glover, and Little rivers are larger than those in the Cossatot and Robinson Fork rivers (Lechner et al. 1987; James 1989). The most abundant populations are apparently found in the section of Glover River upstream of the confluence of Carter Creek to the town of Battiest, Oklahoma (Jones et al. 1983, James 1989) (Fig. 3). James (1989) found that population abundances of leopard darters in Glover River varied from 1 individual at a 225 m^2 site in September 1987 and 1988 to 90 individuals at a 1,275 m^2 site in June 1987. Populations appeared to remain relatively stable from September through March, although populations were generally lower in 1988 than in 1987.

Jones et al. (1983) determined that maximum leopard darter population densities in the Glover River drainage varied from 0.0013 to 0.017 individuals/m^2 (2.2 to 27 fish/100 meters) of stream. Based on these estimates, Jones et al. (1983) estimated the total number of leopard darters inhabiting the Glover River to be 2,827 (*sic*) individuals: 805 inhabiting the East Fork, 1,254 in the West Fork, and 786 in the mainstem. Similar estimates do not exist for any of the other Little River tributaries.

Habitat/Ecosystem

Early characterizations of leopard darter habitat indicated a preference for moderately-swift, gravel-bottomed riffles (Moore and Reeves 1955; Miller and Robison 1973).

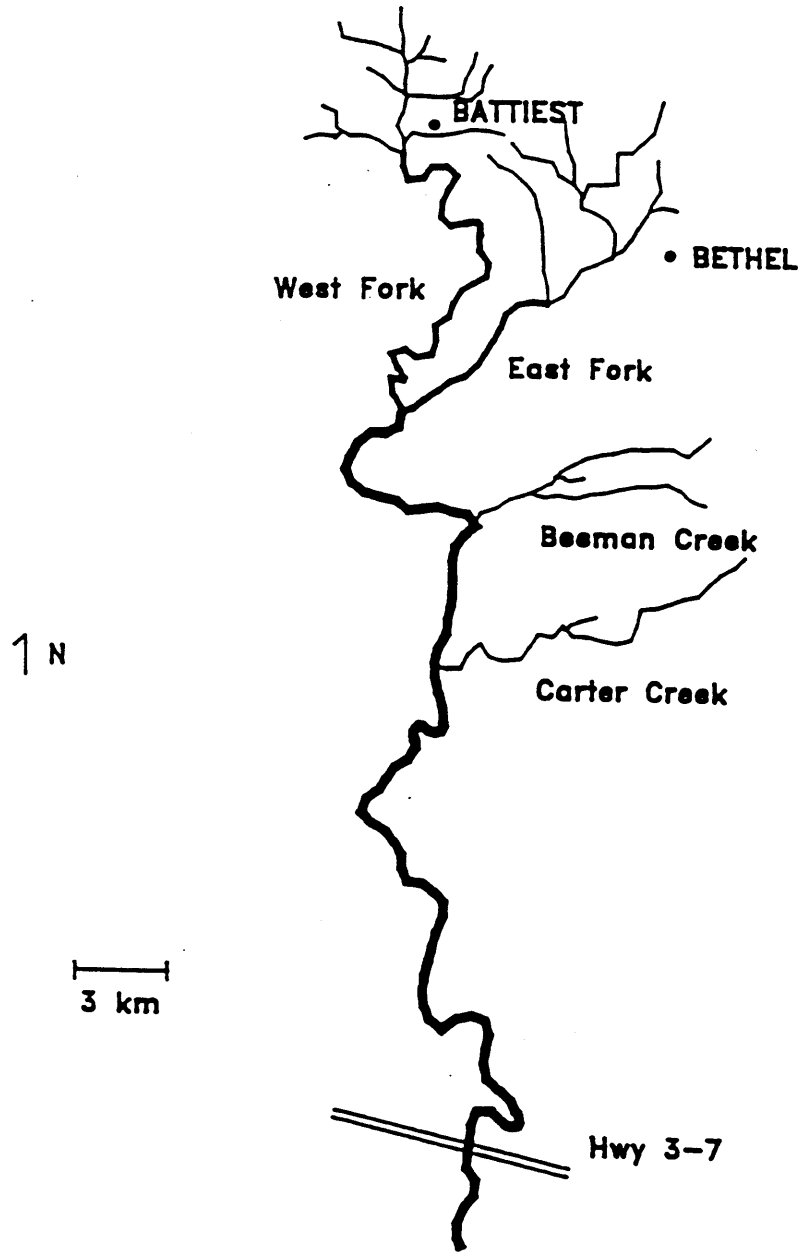

Figure 3. Glover River in McCurtain County, Oklahoma.

These descriptions were probably based on a disproportionate amount of sampling in these habitats during spring months. Recent collectors have concluded that leopard darters are predominantly pool dwellers (Jones et al. 1984; Leon et al. 1987; Lechner et al. 1987; James 1989). Juvenile and adult leopard darters inhabit pools exclusively from June through early February. They exhibit a preference for locations that have water depths of 25 to 100 centimeters (cm), substrates of rubble and boulder, and no detectable current velocity (Jones et al. 1984; James 1989). James (1989) concluded that within any 45 m-long stream section in the Little River drainage, a minimum of 240 m^2 of habitat with the above specifications was required to support leopard darters.

Recent surveys have concluded that leopard darters exhibit a high degree of habitat specificity and not all stream reaches within a particular drainage system contain suitable habitat (Leon et al. 1987; Lechner et al. 1987; James 1989). James (1989) concluded that the availability of suitable rearing habitat in pools and suitable spawning habitat were the primary factors limiting the size of leopard darter populations in Glover River. James (1989) found a significant relationship between the amount of preferred habitat available in an area and the total number of leopard darters present. He also concluded that leopard darters spawned only on riffles with specific attributes (James 1989).

Leopard darter habitat preferences vary by season. Leopard darters were found at significantly greater water depths in winter and spring than in summer and fall. Individuals occupied deeper water during the winter than during any other season. Rubble/boulder substrates were preferred during summer and winter and gravel/rubble substrates were preferred during spring and fall. Leopard darters also exhibited a preference for higher velocities during winter and spring, coinciding with the onset of the spawning season. No differences between juvenile and adult or male and female habitat preferences were found. No information on habitat preferences of larval leopard darters exists.

Stream habitat in the Glover River upstream of the confluence of Carter Creek consists of shallow, wide pools with bedrock, boulder, and rubble substrates separated by riffles, chutes, and low falls over bedrock and boulders. Below Carter Creek, stream habitat consists of long, deep pools separated by shallow riffles with predominantly rubble and gravel substrates.

Existing water quality within Little River tributaries inhabited by leopard darters varies according to the amount of disturbance occurring within the watershed. However, overall water quality within the region is generally good. Water temperatures may vary from 0 °Celsius (C) in winter to 35 °C in the summer. Dissolved oxygen may be as high as 15.0 parts per thousand in winter or as low as 4.0 ppt in the summer. Other reported values include: conductivity - 10-370 micromhos/cm, total dissolved solids - 20 to 100 ppt, suspended solids - 20 to 100 ppt, hydrogen ion concentration - 5.5 to 8.3, total alkalinity ($CaCO_3$) - 10 to 15 ppt, total phosphorus - 0.01 to 0.30 ppt, and total nitrogen - 0.5 to 6.5 ppt. Water quality information collected from approximately 156 sites within the Little River Basin can be found in Maughan et al. (1983).

Life History/Ecology

Reproduction - Leopard darters migrate from pools to riffle tailwaters in February and early March when water temperatures reach 10-12 °C. Spawning occurs from mid-March through mid-April on riffles at water temperatures of 12-17 °C. The non-adhesive, demersal eggs are buried in patches of fine gravel (3 to 10 millimeters (mm) in diameter) at water depths of 30-90 cm and current velocities of 10-35 cm/second (James and Maughan 1989). Eggs hatch in about seven days at 20 °C, and larvae presumably drift downstream into pools (James 1989). The number of mature and immature ova examined in seven specimens varied from 260-418 and 510-2302, respectively (Robison 1978). Examination of five preserved specimens indicated that

distinguishable ova varied from 294 to 757, with a mean of 465 ova per female (James et al. 1991). Observations of spawning females in captivity by James et al. (1991) indicated that clutch size averaged 58.5 and fertilized, water hardened eggs had a mean diameter of 1.37 mm. Spawning occurred only on riffles exhibiting characteristics outlined above.

All spawning individuals appeared to be Age-I and high mortality of these individuals apparently occurs following spawning season (James et al. 1991, James 1989 - see section on age and growth). Continued survival of leopard darter populations is dependent upon Age-I individuals because of the small number of adults surviving to age class II or older. The loss of a single reproductive event/cycle could be devastating to the species.

Age and Growth - Jones et al. (1983) measured the total length of 137 leopard darters collected in the Glover River. Total lengths varied from 45 to 92 mm, with a mean of 70.2 mm. Leon et al. (1987) provided information on total and standard lengths of 16 leopard darters collected from the Cossatot and Robinson Fork Rivers. Total lengths varied from 24 to 69 mm and standard lengths varied from 21 to 59 mm. Mean standard lengths reported by James et al. (1991) from the Glover River varied from 18 to 81 mm. Growth of young-of-the-year appears to be extremely rapid with most individuals attaining an adult size within five to six months.

Scale analysis of 14 preserved specimens by Jones et al. (1983) determined that leopard darters 53 to 74 mm total length were one year of age and those 74 to 80 mm total length were two years of age. Based on this information, Jones et al. (1983) assigned ages to the following size classes: $\leq$ 50 mm total length - age 0, 51 to 71 mm - age I, 72 to 87 mm - age II, and $\geq$ 88 mm total length - age III. Using these measurements, the distribution of captured individuals within the various age groupings were: 0+ - 1.5 percent, I+ - 63.5 percent, II+ - 32.0 percent, and III+ - 3.0 percent (Jones et al. 1983). Robison (1978) collected a mature female, 76.8 mm

standard length, that was reported to be 3+ years of age. Jones et al. (1983) also reported the capture of four individuals exceeding 88 mm total length equivalent to the 3+ age category.

James et al. (1991) observed that leopard darter mortalities in the Glover River between July and September averaged about 60 percent during 1987 and 1988. These observations led to the conclusion that maximum longevity for leopard darters is about 18 months. James (pers. comm. 1992) tracked the growth of two complete cohorts in the Glover River and found no individuals which could be considered as age III+. Many of the age I+ individuals were between 70-80 mm standard length.

Food Habits/Feeding Behavior - Darters are typically first- and second-order carnivores that feed mainly on microcrustaceans as juveniles and on immature aquatic insects as adults (Page 1983). Mayfly nymphs (Ephemeroptera: Baetidae and Heptageniidae), blackfly larvae (Diptera: Simuliidae), and midge larvae (Diptera: Chironomidae) were the only food items in stomachs of 19 leopard darters examined by James et al. (1991). Blackfly larvae (Simulium sp.) and mayfly (Pseudocloen sp.) nymphs were the major food items in seven leopard darter stomachs examined by Robison (1978).

Maughan et al. (1983) characterized the benthic invertebrate community at 42 sites in the Little, Glover, and Mountain Fork Rivers. Sixteen sites were located in the Little River and minor tributaries, 15 sites in Glover River drainage, and 11 in the Mountain Fork River drainage. The abundance of dipterans and ephemeropterans averaged 5.0 and 3.5 percent respectively in relation to the abundance of other taxa collected in the Little River. Chironomids, heptageniids, and siphlonurids were the most abundant taxa within the respective groups. In the Glover River, the relative abundance of dipterans and ephemeropterans averaged 2.9 and 4.7 percent respectively. Chironomids, heptageniids, and baetids were the most abundant taxa within the respective groups. The relative abundance of dipterans and ephemeropterans in the Mountain

Fork Drainage averaged 2.7 and 6.1 percent, respectively. Chironomids, heptageniids, and siphlonurids were the most abundant taxa within the respective groups.

No information on feeding behavior, such as time of feeding, feeding intensity, or seasonal shifts in feeding patterns exists for the leopard darter. Page (1983) states that darters, as a group, have keen vision and are likely to be diurnal, visual feeders. Examination of published literature indicates that considerable dietary overlap may exist between leopard darters and other sympatric Percina species. For example, dietary preferences of logperch (Percina caprodes) and channel darters (P. copelandi) in the Glover River consisted largely of dipterans (chironomids) and ephemeropterans (Jones and Maughan 1987).

Diseases and Parasites - No specific information on diseases exists. James et al. (1991) reported occasionally observing parasitic copepods (Lernaea sp.) attached to the base of either the dorsal or pectoral fins of leopard darters. Small leaches were also infrequently observed attached to either the pectoral or caudal fins. Of the 835 leopard darters captured during 1985-1988, only 30 parasitized individuals were observed; with over 93 percent of the observances occurring during the summer. Page (1983) lists a number of organisms generally known to parasitize various darter species, many of which are also likely to infect leopard darters.

Predation - No specific information on predation exists, although a number of potential predators occur throughout leopard darter range. Page (1983) lists 19 known predators of darters, of which 10 occur within the range of leopard darters. James and Maughan (1989) noted feeding by channel darters on the eggs of leopard darters.

Reasons for Listing/Threats

Impoundments - Six major impoundments have been constructed within the Little River basin, impounding all of the major streams, with the exception of the Glover River. These

impoundments have eliminated crucial spawning and rearing habitat and significantly decreased the distribution of leopard darters. A seventh impoundment, Lukfata Reservoir, has been authorized to be located on the Glover River at river mile 17.3 in McCurtain County, Oklahoma (U.S. Army Corps of Engineers 1975). This reservoir, if constructed, would eliminate 34.7 stream miles of the designated critical habitat of this species and an unknown number of individual darters through inundation and modification of the quality and quantity of downstream flows (U.S. Fish and Wildlife Service 1985). This loss represents approximately 71 percent of the critical habitat designated in the Glover River basin and 25 percent of the total amount of identified leopard darter critical habitat.

Reservoir construction, and to some extent improper construction of low water crossings, fragments leopard darter habitat and creates formidable barriers to the dispersal of leopard darters. Dispersal of leopard darters is critical if populations are to be maintained in streams where environmental extremes or similar perturbations result in localized extinctions. Such movements are also important for sustaining gene flow and genetic diversity.

Water Quality Degradation - Degradation of stream water quality is also a significant threat to the leopard darter. Silviculture has been a major economic activity in the Little River basin since the early 1960's. The ensuing intensive commercial harvest (clear-cutting) of forest products has significantly altered the terrestrial environment of the basin and has been implicated as one of the primary factors responsible for modification of aquatic habitat in the Glover River (Jones 1984) and entire Little River Basin (Leon et al. 1987, Robison 1978, Eley et al. 1975). Potential impacts from road construction (Chutter 1969, Barton 1977, Murphy and Hall 1981) and removal of streamside vegetation (Burns 1972, Kopperdahl et al. 1971) include increased turbidity and sedimentation in streams. Several studies have demonstrated that clear-cutting increases sediment yield, stormflow, and peak flows within harvested watersheds of the Ouachita Mountains

(Miller et al. 1988a, Miller et al. 1988b, Martinez 1982, Miller et al. 1980) and turbidity and suspended solids are known to increase markedly in the Glover River during high flows (Orth 1980, K. Collins pers. obs.). Recent investigations within the Little River basin in Oklahoma found that clear-cutting affected benthic macroinvertebrate populations (Adams and Maughan 1988, Matlock and Maughan 1988) and was the most likely perturbation responsible for observed changes in fish community structure (Rutherford et al. 1987).

Environmental contaminants (e.g., pesticides, fertilizers, acid rain, and untreated wastes) pose a significant threat to leopard darters, particularly as water levels decrease during summer months, concentrating these pollutants. Pesticide application is a common practice used by the timber industry to control unwanted vegetation and insects. Pesticide applications from ground or aerial spraying near streams inhabited by leopard darters could have immediate detrimental effects if pesticides entering the stream reached lethal concentrations. Possible long-term detrimental effects could also occur if pesticides entering the stream decreased the leopard darter's food supply.

Acid precipitation is another form of environmental contamination that appears to pose a potentially significant threat to leopard darter populations. A recent study of rainfall chemistry conducted in southeast Oklahoma by Kress, et al. (1988), found that mean annual values of precipitation pH in the Ouachita Mountain zone varied from 4.51 to 4.59. Precipitation is considered acid when its pH falls below 5.65, the pH level determined by the natural carbon dioxide content of the atmosphere (Stumm and Morgan 1981). Preliminary measurements of total alkalinity in streams containing leopard darters suggest that these streams may possess very low natural buffering capacities and thus may be particularly vulnerable to adverse impacts from acidic precipitation. Such impacts could include both direct toxicity to eggs and fry from acid stress and

metals liberated in acidic environments; and, indirect effects due to the elimination of food items utilized by leopard darters.

Water quality degradation associated with gravel dredging/mining operations does not appear to be a major threat to leopard darters at current activity levels. Permits have presently been granted for 13 such operations within the Little River Basin of Oklahoma (8) and Arkansas (5). Two operations, located in Polk County, Arkansas, are the only permitted operations within the present distribution of leopard darters. Gravel dredging/mining operations potentially could result in increased sediment loading, habitat destruction and modification, and destruction of vegetated riparian areas. However, unless gravel is stockpiled in a river, no Clean Water Act Section 404 permit is required and the operation does not fall under the purview of Section 7 of the Endangered Species Act. National Pollution Elimination Discharge System permits are rarely required, and only if a gravel washing operation exists in conjunction with the mining activity. One gravel dredging facility, located on the Glover River near the Oklahoma Highway 3 bridge, may have been responsible for the extirpation of leopard darter populations downstream of the bridge.

The rapid expansion of the intensive poultry and swine farming industry in southeastern Oklahoma and southwestern Arkansas is also considered a potential threat to the leopard darter. Treatment of residue from these facilities typically consists of land application and may include incorporation of wastes into the soil. Generally, proper application of these wastes presents little threat to leopard darters. However, disposal of these wastes for the most part is unregulated. Nutrient laden runoff from improper disposal techniques potentially could enter streams inhabited by leopard darters and adversely impact water quality.

Conservation Measures

Recovery efforts undertaken since 1984 have primarily consisted of research funded by the U. S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the Oklahoma Department of Wildlife Conservation to obtain additional information on the distribution, life history, and ecology of leopard darters. The Corps of Engineers funded a study to determine the extent of leopard darter distribution throughout the upper portions of the Little River and Mountain Fork River Drainages in Oklahoma and the Cossatot, Mountain Fork, Rolling Fork, and Saline River Drainages in Arkansas. These efforts completed most of the recovery tasks previously outlined under Item 1.0, Identification of important habitat, in the 1984 recovery plan.

The U. S. Fish and Wildlife Service and Oklahoma Department of Wildlife Conservation funded a reproductive ecology study through the Oklahoma Cooperative Fish and Wildlife Research Unit to address aspects of recovery task 2.1, Reproductive Ecology, in the 1984 recovery plan. This study investigated spawning attributes, such as season and length of spawning period, spawning behavior, length of incubation, and time of hatching, and characterized spawning habitat.

The State of Arkansas, in cooperation with several private organizations and corporations, has recently completed a two phase protection effort on the upper Cossatot River that indirectly benefits recovery of the leopard darter. In 1987, 11 miles of the Cossatot River between State Highways 4 and 246 were set aside as the Cossatot River State Park and Natural Area. This preserve protected over 4,400 acres of riparian corridor along the Cossatot River and includes all three of the 1986 leopard darter collection localities documented in Leon et al. (1987). In April of 1992, a 26.1 mile segment of the Cossatot River from the confluence of Mine Creek within the Ouachita National Forest downstream to Duchett's (Duckett's) Ford within the Gillham Reservoir

Project boundary was designated as a component of the National Wild and Scenic Rivers System. In addition, a 4.7 mile segment of Brushy Creek, a major tributary of the Cossatot River above Arkansas State Highway 246, was also designated a component of the National Wild and Scenic Rivers System. The National Wild and Scenic Rivers and State Park designations will ensure that the Cossatot remains a free-flowing stream and prohibits commercial and industrial uses which are inconsistent with these designations. These measures provide considerable protection for leopard darter population(s) within the Cossatot River and represent a significant accomplishment under Item 3.0, Habitat management and protection in the 1984 recovery plan.

Ongoing conservation measures include an investigation by the San Marcos National Fish Hatchery and Technology Center to determine additional reproductive (recovery task 2.1, Reproductive Ecology) and early life history (recovery task 2.2, Early Life History) characteristics of the leopard darter through captive propagation. Efforts focused on compiling reproductive/early life history information (numbers of spawning fish, eggs, fry, and fingerlings produced; larval food habits, survival rate, and growth) and developing general guidelines for the laboratory rearing of the species, primarily by controlling temperature and photoperiod. During these experiments, females were induced to deposit eggs but fertilization apparently never occurred. All 43 individuals captured for use in the investigation died, including the juveniles, before the experiment could be completed. Some mortality of adult fish was expected because the leopard darter has a relatively short life span; however, juvenile mortality was higher than anticipated. Leopard darters may be less tolerant of captivity than other species of darters. The study highlighted the importance of existing spawning and rearing habitat to the recovery of the leopard darter. Because culture techniques used successfully for the fountain darter (Etheostoma fonticola) appeared to be unsatisfactory for the leopard darter, San Marcos is attempting to develop culture techniques suitable for the genus Percina. Future investigations are focusing on

refining spawning techniques with surrogate species such as dusky darters (P. sciera) and longnose darters (P. nasuta). Some of this information could be applicable to future leopard darter recovery efforts.

The Environmental Protection Agency's Endangered Species Protection Program (54(126) FR:27984-28008), initiated in 1987, is an ongoing effort designed to ensure consideration of federally listed species during the pesticide registration process. The 1988 amendments to the Endangered Species Act require that the Environmental Protection Agency work jointly with the U.S. Department of Agriculture and the U.S. Fish and Wildlife Service to identify measures, such as pesticide use restrictions, necessary to implement a pesticide product labeling program that protects listed species; and, develop an education/outreach program for pesticide users. A map depicting the distribution of leopard darters in Oklahoma has been prepared for inclusion in the labels and county specific Pesticide Use Bulletins for all pesticides, currently 28, whose use could jeopardize the continued existence or result in incidental take of leopard darters. This information is currently available to the public although compliance is voluntary. Complete implementation of this program, including mandatory compliance and adequate enforcement, should provide substantial protection to leopard darters and their habitat from inappropriate use of pesticides.

Evaluation and resolution of potential impacts to leopard darters, designated critical habitat, and other essential habitats is an ongoing effort of the U. S. Fish and Wildlife Service's Fish and Wildlife Enhancement Division and counterparts in the Arkansas Game and Fish Commission and Oklahoma Department of Wildlife Conservation. Federal agencies are required, under Section 7 of the Endangered Species Act, to consult with the U. S. Fish and Wildlife Service on any action they construct, fund or authorize to determine if the proposed action may affect listed species, such as the leopard darter or its critical habitat.

The leopard darter is classified as threatened by the states of Oklahoma and Arkansas and receives limited protection under the statutes of both states. Violations against an Oklahoma state listed species are punishable by up to $1,000 in fines and/or imprisonment in county jail for up to 30 days. The Arkansas Game and Fish Commission may levy fines of $500 to $2000 for violations against federally protected species in Arkansas. Federal law provides for punishment of up to one year in prison plus a maximum fine of $100,000 for an individual and $200,000 for a corporation or organization.

Strategy of Recovery

Deauthorization of the proposed Lukfata Reservoir Project is the most important task in this recovery plan and should take precedence over all other actions. Full recovery of the leopard darter cannot be accomplished as long as this threat exists. Further destruction and fragmentation of leopard darter habitat would significantly reduce any chance of long term survival.

Several additional habitat protection measures have also been identified as key components of this recovery plan. The Glover River drainage is presently thought to support the largest population(s) of leopard darters. Protection of essential habitats, particularly in the Glover River, is essential to the continued existence of the leopard darter and has been determined to be a high priority task.

Additional life history and ecological investigations appear warranted. These studies would assist in the determination of the number and spatial arrangement of leopard darter populations required for short- and long-term recovery. Information on the genetic diversity of the leopard

darter is essential to preservation or enhancement of the species' long-term evolutionary potential and has been determined to be a high priority task.

The attitudes and perceptions of the public can significantly influence the success of any recovery effort. Several tasks have been incorporated into this plan which are designed to enhance public awareness and help ensure the success of specific recovery tasks.

Re-establishment of leopard darter populations within its historic range and enhancement of existing low quality habitat are additional tasks designed to promote long-term recovery of the leopard darter. Protection of existing populations within presently occupied habitat, although essential to the recovery of the leopard darter, is only maintenance of existing populations through intensive management and does not ensure the survival of the species through time.

Deauthorization of the Lukfata Reservoir Project, protection of essential habitat in the Glover River, and preservation of sufficient genetic variation to maintain the leopard darter's long-term evolutionary potential are all **priority one** tasks. These tasks have been identified as those actions which must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Protection of essential habitats in segments of the remaining stream systems, certain ecological investigations, and conducting information and education programs are the most important **priority two** tasks.

All recovery tasks proposed to be carried out by a federal agency are subject to the provisions of the National Environmental Policy Act (NEPA) if that task constitutes a major federal action. Such actions will only be implemented in compliance with NEPA and would undergo complete public review and comment prior to implementation. Recovery plans do not obligate an agency, entity, or persons to implement the various tasks listed in the plan.

PART II: RECOVERY

A. Objective and Criteria

The objective of this recovery plan is to delist the leopard darter. The species may be considered for delisting when tasks 1.1 and 1.2 have been completed, provided results of task 3.1 indicate that the prognosis for long-term recovery is favorable. These delisting criteria are preliminary and may be revised on the basis of new information. Specific criteria specifying the number and spatial arrangement of leopard darter populations required for short- and long-term recovery have not yet been determined. The implementation of studies identified under Tasks 2.0 and 3.0 in this recovery plan should provide the necessary data from which concise, measurable criteria can be established.

The estimated date for recovery is 2003. However, the continued existence of the leopard darter is dependant upon the maintenance of free-flowing streams, and sections thereof, and recovery cannot occur until all authorized, but unconstructed, impoundments are deauthorized. Because delisting is dependent upon the removal of this threat, the date for recovery is somewhat tenuous. Deauthorization is in large part dependant upon actions over which the U. S. Fish and Wildlife Service has no direct control. Planning for the proposed Lukfata Reservoir project has been ongoing since 1957 and deauthorization does not appear likely before 1999. Planning for the Lukfata Reservoir project continued through fiscal year 1991, despite a March 11, 1985, jeopardy biological opinion, without reasonable and prudent alternatives.

In accordance with the Fish and Wildlife Service's Species Recovery Priority System, the leopard darter has been assigned a recovery priority number of 11C. This system assigns a species a numerical rank between 1 and 18 according to the degree of threat, recovery potential,

taxonomic distinctness, and presence of an actual or imminent conflict between the species' conservation and development or other economic activities.

B. Narrative Outline for Recovery Actions

1. **Provide adequate protection from proposed developments and land-use practices that threaten to adversely impact leopard darters or their essential habitat.** Major threats to the leopard darter include habitat destruction by impoundments and habitat degradation due to commercial logging, intensive poultry and swine production, and acid precipitation. Construction of Broken Bow, De Queen, Gillham, and Pine Creek reservoirs destroyed large sections of formerly occupied habitat and completely isolated leopard darter populations within the affected streams to reaches upstream of the reservoirs. Construction of Lukfata Reservoir or impoundment of existing sections of flowing streams would induce additional habitat losses. These habitat losses would compromise the species' survival and prevent recovery. Restoration of former habitat, except in a few limited cases, is not possible without the removal of existing dams.

Viable leopard darter populations depend heavily upon successful reproduction by first year spawners because of the small number of individuals surviving to age class II or older. The loss of a single reproductive event would be devastating to individual populations. Any recovery efforts designed to protect leopard darters should include efforts to ensure successful annual recruitment by protecting spawning and rearing habitats and maintaining suitable water quality. For the purposes of this recovery plan, protection includes any

measure or combination of measures that eliminates or minimizes negative impacts to leopard darters or their habitat.

1.1 **Deauthorize the proposed Lukfata Reservoir project.** The proposed Lukfata Reservoir (U.S. Army Corps of Engineers 1975) would inundate or adversely impact over 71 percent of the critical habitat designated in the Glover River. Should Lukfata Reservoir be constructed, the total number and distribution of leopard darters remaining in the wild would be significantly reduced and likely result in the status of the leopard darter being upgraded to endangered. Completion of this task is necessary to prevent extinction.

Deauthorization of Lukfata Reservoir may be politically and to some extent, socially unacceptable because flood protection options would be restricted. However, non-structural flood control measures, although unacceptable to a few landowners, could provide the necessary flood protection while enhancing the survival of the leopard darter. In some instances, other structural alternatives may also provide flood control without significantly impacting the leopard darter or its habitat. Steps should be taken to begin negotiations to initiate the deauthorization of Lukfata Reservoir, and, if necessary, seek utilization of non-structural and/or other structural measures as a means of providing adequate flood protection.

1.2 **Ensure protection of essential habitat and stream water quality.**

Buffer strips of riparian vegetation adjacent to affected stream courses have been shown to ameliorate some of the impacts of timber harvest on aquatic systems (Noel

et al. 1986, Erman and Mahoney 1983, Newbold et al. 1980, Erman et al. 1977, Stone 1973, Haupt and Kidd 1965), although a recommendation for an optimum width has not been reported in the literature. U.S. Forest Service regulations [36 CFR 219.27(e)] specify that a 100-foot buffer strip should be protected along perennial water bodies to minimize changes in water temperature or sedimentation resulting from timber management activities.

Protection of riparian vegetation would help preserve essential habitats, such as spawning and rearing habitat, and maintain the water quality in streams primarily by buffering streams from the effect of siltation due to clear-cutting and road construction in the watershed. Riparian corridors would also help to buffer stream waters from contamination by pesticides used in commercial forestry activities and eutrophication by poultry/swine farms and other forms of non-point source discharges. Important habitat could be adequately protected by preserving, at a minimum, a 100-foot corridor of riparian habitat on both sides of each perennial stream inhabited by leopard darters. Efforts should first be directed at protecting known spawning riffles and rearing pools. Fencing of protected areas would eliminate or reduce indiscriminant removal of riparian vegetation and impede grazing. An additional buffer of 150-400 feet in average width, would further minimize the influx of logging debris and sediment, excessive nutrients from runoff at swine and poultry operations, and provide a measure of protection from the application of forestry pesticides.

1.21 **Develop and implement a detailed habitat protection plan for the Glover River.** The largest known population(s) of leopard darters are currently found

in the Glover River from the confluence of Carter Creek upstream to near the community of Battiest (Jones et al. 1983, James 1989). Unless these populations are protected, the survivability of the leopard darter will be severely reduced. An additional segment of the West Fork extending from Battiest upstream to a point where the stream channel enters sec. 24, R. 22 E., T. 1 S. was identified by Jones (1984) as an area of important habitat based on the estimated production of leopard darters. The portion of the Glover River composed of these two segments should be the highest priority for protection. Completion of this task is necessary to prevent extinction of the leopard darter.

The habitat protection plan should incorporate all available options for habitat protection, with emphasis on providing technical and financial assistance to private and corporate landowners. Intensive efforts to educate and cooperate with riparian landowners, primarily to secure protection through conservation agreements, may be required. This effort should consider enlisting the assistance of The Nature Conservancy's Natural Areas Registry Program (Registry Program). The actual cost of task completion is dependent upon the amount of participation provided by private parties.

Habitat protection within the Glover River Basin would also benefit several candidate species - Ouachita Mountains indigo (Amorpha ouachitensis), Cumberland sand grass (Calamovilfa arcuata), Waterfall's sedge (Carex latebracteata), southern ladies slipper (Cypripedium kentuckiense), Ouachita

Mountain shiner (Lythrurus snelsoni), eastern small-footed bat (Myotis subulatus leibii), southeastern myotis (M. austroriparius) and southeastern big-eared bat (Plecotus rafinesquii).

1.22 **Prepare a land ownership map incorporating all known leopard darter populations within the Little River Basin**. Land ownership maps should be prepared for all Little River tributaries containing suitable leopard darter habitat to facilitate landowner contact. A land ownership map of the Glover Basin has already been prepared. Where possible, existing water right reservations should also be determined.

1.23 **Encourage private sector habitat protection in additional stream systems**. Protection of essential habitats not requiring intensive public management efforts would be achieved through a program, such as Partners for Wildlife or the Registry Program, designed to encourage protection and management by the private landowner. Efforts should emphasize education of and cooperation with riparian landowners, primarily to secure protection through conservation agreements. Landowner contacts should be initiated, perhaps by letter, to determine their willingness to enter into an agreement and to provide the landowner with information on leopard darters. Initial contacts should also encourage landowners to report all fish kills to the appropriate agency. Highest priority should be to contact landowners located near known spawning and rearing areas.

1.231 **Preservation of spawning habitat and stream water quality in the upper Little River**. Leopard darter populations in the upper Little River are widely distributed; however, fewer total numbers and known localities exist in the upper Little River than in the Mountain Fork River (Lechner et al. 1987). The number of tributary refugia are also much lower in the Little River than in the Mountain Fork River. Isolation and lack of suitable tributary refugia are significant threats to populations in the Little River. Protection of populations in the upper Little River is a higher priority than protection of populations in the Mountain Fork River.

The highest concentration of leopard darters within the Little River occur in the upper reaches. The section from the confluence of Honobia Creek (sec. 30, R. 23 E., T. 1 N.) downstream to the confluence of Black Fork Creek (sec. 22, R. 20 E., T. 1 S.) is believed to support the largest populations. This area should be the highest priority for all habitat protection efforts in the upper Little River basin.

1.232 **Preservation of spawning habitat and stream water quality habitat in the Robinson Fork River**. Leopard darter populations occurring in Polk County, Arkansas, from sec. 21, R. 32 W., T. 6 S. to sec. 32, R. 32 W., T. 6 S. should receive the highest priority protection in Arkansas. Existing leopard darter populations in the

Cossatot River, based on the 1987 surveys, are currently under public ownership.

1.233 **Preservation of spawning habitat and stream water quality in the upper Mountain Fork River**. Leopard darter populations in the Mountain Fork appear to be more secure than those in other drainages due to the extensive network of tributaries that may offer some protection from a possible catastrophic extirpation through the provision of potential refugia. The area extending from the confluence of Rock Creek (sec. 24, R. 25 E., T. 1 S.) downstream to the headwaters of Broken Bow Reservoir (sec. 21, R. 25 E., T. 2 S.) should be the highest priority based on an absence of suitable refugia and on the numbers of darters observed.

1.234 **Preservation of spawning habitat and stream water quality habitat in tributary streams**. Protection of leopard darter populations in tributaries has been suggested as a key to stabilizing leopard darter populations, primarily by providing refugia or sources of recolonization (Lechner et al. 1987). Areas that have been suggested for protection include: Big Eagle Creek from sec. 20, R. 25 E., T. 1 N. downstream to its confluence with the Mountain Fork River in sec. 26, R. 25 E., T. 1 S. in McCurtain and Leflore Counties; East Boktuklo Creek from sec. 7, R. 25 E., T. 2 S. downstream to its confluence with Boktuklo Creek in sec. 13,

R. 24 E., T. 2 S. in McCurtain County; Boktuklo Creek from sec. 13, R. 24 E., T. 2 S. downstream to its confluence with the Mountain Fork River in sec. 9, R. 25 E., T. 2 S. in McCurtain County; and Honobia Creek from sec. 12, R. 22 E., T. 1 N. downstream to its confluence with the Little River in sec. 30, R. 22 E., T. 1 N. in Pushmataha and LeFlore Counties.

1.24 **Complete protection of essential habitats and stream water quality in the Little River Basin through public ownership**. Public ownership provides the most permanent form of protection, and in some instances, the only means by which necessary protection can be maintained. Often, intensive management is required if desired protection is to be realized. Protection of essential habitats would be achieved through donations, fee title acquisition, easements, leases, and conservation agreements. All fee acquisitions would be on a willing seller basis. Once land is in public ownership, water rights necessary to maintain instream flows essential for leopard darter reproduction should be secured to ensure protection of leopard darter habitat.

1.25 **Enforce water quality regulations**. Protection provided by existing State and Federal water quality regulations dealing with point and non-point sources of pollution should be stringently enforced and appropriate actions taken to ensure strict compliance. Appropriate actions should also be taken to seek improvement and consistency in existing regulations and standards that would assist in the recovery of the leopard darter.

1.251 **Point source discharges**. The locations of all permitted point source discharges within and upstream of areas inhabited by leopard darters in Oklahoma and Arkansas should be determined, the effectiveness of the conditions for each permit should be evaluated, and improvement in the quality or conditions of the permitted discharges should be sought where existing discharges are impacting or could potentially impact leopard darters or their habitat. Compliance with the consultation provisions of Section 7 of the Endangered Species Act should also be sought with the Environmental Protection Agency or designated State agency where granting of a National Pollution Discharge Elimination System permit is required.

1.252 **Non-point source discharges**. Appropriate actions should be taken to improve State water quality standards, particularly where non-point source pollution may be impacting leopard darters or their habitat. For example, Oklahoma's water quality standards provide only superficial protection from non-point source discharges. Non-point source discharge standards consist of the best management practices set by the Oklahoma Department of Agriculture and Oklahoma Conservation Commission for forestry and farming/ranching activities. Compliance with the best management practices is voluntary. The effectiveness of these best management practices should be evaluated and improved where

beneficial to do so. Action should also be taken to improve compliance with water quality standards for non-point source discharges.

1.26 **Evaluate or monitor all present and proposed activities which may impact leopard darter habitat**. A comprehensive program designed to monitor all present and proposed construction activities and land-use practices in the Little River system should be implemented. This program would be used to negotiate the modification of developments or practices that may harm leopard darters or essential habitats. Consideration should be given to conducting biennial overflights of entire streams, concentrating on periods of normal to low flow.

1.261 **Monitor clear-cutting activities**. The availability of suitable rearing habitat in pools and suitable spawning habitat in riffles are the primary factors limiting the size of leopard darter populations. Clear-cutting operations should be monitored to ensure that essential habitats are not disturbed, particularly riffle areas during the spawning season. Upon identification of potential problems, measures should be taken, in conjunction with Weyerhaeuser and other timber companies, to encourage correction of the identified problem.

1.262 **Evaluate threat posed by intensive poultry and swine operations**. The intensive production of poultry and swine has

been increasing over the past 15-20 years, particularly in southeastern Oklahoma. These livestock facilities have the potential to generate tremendous quantities of waste with very little regulation of its disposal. Placement of the facilities near an inhabited stream segment could severely degrade water quality if disposal is not conducted in a proper manner.

1.2621 **Determine the location, number, ownership, and production from all intensive swine and poultry production facilities**. Facilities within the upper Little River, upper Mountain Fork River, and entire Glover River drainages have the greatest potential for impacting leopard darters and efforts should concentrate on these areas. Information gathered during completion of this task would be used to determine the significance of the threat from these facilities and to provide baseline information for a landowner contact and education program.

1.2622 **Conduct a landowner contact and education program**. This task could be completed in conjunction with tasks 1.21 and 1.23.

1.2623 **Prepare a Habitat Conservation Plan according to the provisions of Section 10 of the Endangered Species Act**. If repeated take of leopard darters, such as fish kills from improper disposal of livestock wastes, is determined to be linked with these operations, a Habitat Conservation Plan designed to minimize such take should be implemented.

1.263 **Assess the impact of existing stream crossings as they may affect leopard darter dispersal**. Improper design and placement of culverts at stream crossings have been shown to obstruct movements of many stream fishes (Dane 1978, Anderson and Bryant 1980). Recent investigations within the Ouachita National Forest have indicated that darter movements may be impacted by inadequate stream crossings (Pers. Comm. Richard Standage, Fisheries Biol., U.S. Forest Serv.). Some crossings may be operating as barriers resulting in additional fragmentation of leopard darter populations. The design and placement of existing low-water crossings should be evaluated to determine which structures may be inhibiting leopard darter dispersal. Defective crossings should be modified to eliminate or minimize these impacts. A standard design recommendation, incorporating dispersal requirements of leopard darters, should be developed and implemented for all proposed stream crossings within areas inhabited by leopard darters. This task could be completed in conjunction with task 2.2. Action should also be taken to ensure that the placement of

these structures, within areas inhabited by leopard darters, are evaluated under Section 404 of the Clean Water Act. Authorization under Nationwide Permit number 26 is not appropriate in these instances.

1.264 **Monitor compliance with pesticide use restrictions within areas occupied by leopard darters**. Pesticide applications should be monitored to ensure that pesticides do not impact streams. Compliance with the existing restrictions is currently voluntary.

1.265 **Determine the magnitude of threat posed by acid precipitation**. Streams occupied by leopard darters should be surveyed to determine their vulnerability to acid precipitation. Measurements should include hydrogen ion concentration, total alkalinity, conductivity, and hardness from sampling stations located in hydrologically isolated watersheds. In streams where the natural buffering capacity is low or depressed pH levels are found, evaluation of the aquatic invertebrate community should be undertaken to determine if impacts have occurred. Where possible, measures should be implemented to minimize the impact of acid precipitation on leopard darter populations.

2. **Determine and improve the condition of existing populations and essential habitats for leopard darters**. Status of existing leopard darter populations and essential habitats should be monitored every two or three years to determine general trends in population abundance and success of recovery actions.

2.1 **Determine the extent of suitable leopard darter habitat within the Little River System**. Accurate estimates of the numbers of leopard darters surviving in the wild cannot be obtained until the amount of habitat within the system considered suitable for occupancy by the leopard darter is known. This information is essential to full completion of tasks 1 and 5, and would aid, in conjunction with completion of task 2.2, the development of criteria specifying the number and spatial arrangement of leopard darter populations required for short- and long-term recovery.

2.2 **Determine leopard darter movement and survivorship patterns**. Information on movements/dispersal, longevity, and population fluctuation cycles is crucial to determining the number, degree of isolation, and spatial boundaries of individual leopard darter populations. Completion of this task will also clarify the species' vulnerability to inbreeding depression, as expressed by reduced viability and fecundity. A mark and recapture investigation should provide the necessary information required to complete this task. The selected technique should use marks that do not appreciably increase the chances of mortality or infection, such as small, binary coded or visible implant tags. Mutilation, particularly fin clipping, should only be used as a last resort. A surrogate species should be evaluated prior to using this technique on leopard darters to determine if any unexpected reactions to the mark might occur in leopard darters. Recapture efforts should be conducted at least twice, preferably three, times per year for a three year period to indicate how populations cycle and to gauge longevity of individuals.

2.3 **Establish permanent monitoring sites throughout the Little River system.** Permanent sites where leopard darters are known to occur should be established in each drainage to facilitate periodic estimates of leopard darter population trends and abundance. Locations of previously sampled sites in the Little River system can be found in Leon et al. (1987), Lechner et al. (1987), and James (1989). Jones (1984) also provided suggestions for locations of permanent monitoring stations.

Estimates of population abundance should be made in late summer or early fall as an indication of the number of individuals surviving to reproduce. Underwater observation using masks and snorkels appears to be the most efficient method for obtaining population estimates (James 1989). Actual counts of leopard darters should be made along transects at each site. Sites should be sampled only when underwater visibility is at least one meter. Personnel performing surveys should be very familiar with underwater sampling and identification of leopard darters. Blackside darters and channel darters are occasionally found in the same habitat as leopard darters and may be difficult for untrained personnel to distinguish.

2.4 **Determine importance of small tributaries as spawning areas for leopard darters.** Leopard darters may be absent from many of the small tributaries during most of the year due to low water levels. However, these tributaries may be important spawning areas and refugias for larval leopard darters. Surveys of the small tributaries to major streams inhabited by leopard darters should be performed during March and April to determine their importance as spawning areas.

2.5 **Determine leopard darter distribution, abundance and extent of suitable habitat within the Ouachita National Forest in Oklahoma and Arkansas.**

3. **Conduct research on existing populations to determine genetic diversity and minimum viable population size.** A thorough understanding of the conservation genetics of the leopard darter is essential to the preservation and enhancement of the species' long term evolutionary potential. Specifically, information concerning the geographic limits and spatial arrangement of genetically distinct populations and subpopulations as well as the minimum population size to maintain viability and maximize genetic diversity should be high priority for future research.

3.1 **Determine amount of genetic variation among populations within and between major streams.** Populations of leopard darters were isolated in each of the five major Little River tributaries following construction of several impoundments within the drainage. This isolation may have resulted in loss of important genetic information. Knowledge of the amount of genetic variation among individuals within populations and genetic variation among populations within and between streams is necessary before many management decisions, particularly concerning captive propagation, refugia populations, and reintroductions, can be made (Echelle 1988). This task will provide information on long term recovery potential of the leopard darter and help direct management actions affecting survivability of the species. Completion of this task is necessary to prevent extinction.

Protein electrophoresis, using at least 30 to 40 gene loci, if possible, should be used to determine genetic variation. Priority should be given to

the use of tissues, such as blood, fins, etc., which do not require sacrificing large numbers of individuals from any given population. Populations appearing to be at saturation and exhibiting the greatest variation would be the best candidates for reintroduction/transplanting efforts because of their enhanced likelihood of survival in a new environment.

3.2 **Determine minimum number of males and females required to sustain a viable population**. Recent surveys in the Little River system have expanded the known distribution of leopard darters (Leon et al. 1987; Lechner et al. 1987). However, less than 10 individuals were found at most of the recently discovered sites. These sites may not represent permanent, viable populations; and, based solely on these discoveries, conclusions regarding the status of leopard darters (increases in number or range) cannot be made. Studies should be conducted to determine the minimum number of each sex required to sustain a permanent population. This information would then be used to determine the total number of viable leopard darter populations remaining.

4. **Conduct an information and education program**. Increasing awareness of the general public is an important component of any recovery program. The attitudes and perceptions of the public can have a tremendous influence on the success of recovery tasks.

4.1 **Complete preparation of a leopard darter brochure**. The design and text for a brochure on the leopard darter is scheduled to be completed in February 1993. The printing of this brochure is an integral component of any public or private education

program. The brochure should be printed and distributed according to the needs outlined in previous tasks.

4.2 **Erect displays at several public use facilities located within leopard darter historic range**. The Little River National Wildlife Refuge and the Cossatot River State Park Natural Area could erect displays providing information on the life history and habitat requirements of the leopard darter. Other state wildlife management areas in Arkansas, such as Caney Creek, DeQueen Lake, Dierks Lake, Gillham Lake, Howard County, and Millwood may also be appropriate for the placement of displays. Corps of Engineers project offices at Broken Bow, Pine Creek, Gillham, Dierks, DeQueen, and Millwood Reservoirs in Oklahoma and Arkansas should also be considered as possible locations for increased interpretive programs.

5. **Enhance and re-establish leopard darter populations within species' historic range**. Re-establishment of leopard darters within the species' historic range is essential for long-term recovery. New satellite populations would help reduce the susceptibility of catastrophic extinction of wild populations within certain drainage systems and possibly augment genetic variability of small populations that may already have lowered genetic diversity. Re-establishment, as used in this plan, is release and subsequent successful reproduction of founding individuals, followed by successful reproduction of their offspring. Translocation of exclusively wild caught individuals is preferred methodology due to the greater likelihood of success when compared to the release of captive reared individuals. Caution must be exercised to avoid genetic contamination of existing populations. Individuals should only be translocated into unoccupied suitable habitat. Donor populations should be determined using

available population information and information derived from completion of tasks 3.1 and 2.2.

Factors shown to affect the outcome of a translocation in a terrestrial environment, as discussed in Griffith et. al. (1989), may also operate in an aquatic environment. Any translocation effort should attempt to release the largest possible number of founders per site, while utilizing the largest number of release sites the number of founders will permit. Temporary removal of predators and competitors from a release site may also be necessary to help provide abundant resources, affording transplants an increased chance of survival. Translocations of individuals into areas with potential competitors were found to be less successful than translocation into areas without competitors. Translocation sites that are afforded some protection, such as within the Ouachita National Forest, or for sites that will provide some protection prior to and following release should receive highest priority. Release attempts should be monitored for at least three years to evaluate causes of death or basis for survival. Re-evaluation of factors affecting success should be conducted for all unsuccessful releases prior to attempting another release. Guidelines published by the American Fisheries Society (Williams et al. 1988) should be followed when possible.

5.1 **Re-establish additional populations in the Cossatot and Robinson Fork drainages**. Due to the small size and isolation of populations in the Robinson Fork and upper Cossatot drainages, these populations are extremely vulnerable catastrophic extirpation. Initial efforts should focus on these drainages. Both should be evaluated for potential sites and an information and edu developed prior to initiating any translocation. If the translocati

additional reintroductions should be attempted in other areas of unoccupied habitat, such as the upper Rolling Fork River.

5.2 **Initiate habitat enhancement projects to increase abundance and distribution of leopard darters**. Lack of suitable spawning and rearing habitat appears to limit population size and distribution of leopard darters (James 1989). In areas lacking suitable habitat, habitat modification could increase amount of usable habitat. Habitat enhancement could be attempted in areas inhabited by leopard darters where little suitable habitat exists or in appropriate unoccupied habitats prior to release of translocated individuals. Enhancement of existing spawning habitat should be attempted if previous efforts indicate spawning may be improved by these measures. Modification of spawning habitat could involve placing artificial spawning substrate (wire baskets of fine gravel) in riffle areas with the appropriate water depth and velocity (see life history section in Part I) during March and April. Modification of rearing habitat could be accomplished by building "islands" of habitat composed of rubble and boulders in pools at water depths of 25-75 cm.

5.3 **Re-establish leopard darters downstream of reservoirs**. Reservoirs affect leopard darter dispersal and colonization by eliminating interchange between the upstream and downstream sections of river. Typically conditions below reservoirs are unsuitable for leopard darters, with the possible exception of Gillham Reservoir, and cannot be modified to ensure the success of a potential re-introduction. Habitat conditions in the upper sections of the lower Cossatot from Gillham Dam downstream to State Highway 380 east of King, Arkansas, appear to provide the only opportunity for re-introduction

below a reservoir. This section of stream should first be surveyed for suitable release sites. Negotiation of the restoration of stream flows typical of the Cossatot River prior to impoundment, or at least levels that are not deleterious to leopard darters, may be required. Initiation of a public education program may improve the public's perception of the project. Genetic swamping of individuals having local adaptations is not a concern because the area is uninhabited and artificially isolated from upstream populations by Gillham Reservoir.

6. **Develop a plan to monitor leopard darters once delisting appears imminent**. A plan, utilizing sites previously delineated under task 2.3, to monitor leopard darter populations should be developed. This plan would be implemented in accordance with the 1988 amendments to the Endangered Species Act, Section 4(g).

Literature Cited

Anderson, L. and M. Bryant. 1980. Fish passage at road crossings: an annotated bibliography. U. S. For. Serv. Gen. Tech. Rept. PNW-117. Pacific Northwest Forest and Range Exp. Sta. pp.

Bailey, R. M., H. E. Winn, and C. L. Smith. 1954. Fishes from the Escambia River, Alabama and Florida, with ecologic taxonomic notes. Proc. Acad. Natural Sci. Philadelphia 106:109-164.

Buchanan, T. M. 1974. Threatened native fishes of Arkansas. Pages 67-92 in Arkansas natural area plan. Arkansas Dept. of Planning, Little Rock, AR. pp. 67-92.

Cloutman, D. G., and L. L. Olmsted. 1974. A survey of the fishes of the Cossatot River in southwestern Arkansas. Southwestern Naturalist 19:257-266.

Dane, B. G. 1978. A review and resolution of fish passage problems at culvert sites in British Columbia. Can. Fish. Mar. Serv. Tech. Rept. No. 810. Vancouver, B. C. 137 pp.

Echelle, A. A. 1988. Review of genic diversity and conservation genetics in fishes of U. S. Fish and Wildlife Service Region 2, with a suggested program of conservation genetics. Final Report, U.S. Fish and Wildlife Service, Albuquerque, NM. 42 pp.

Eley, R. L., J. C. Randolph, and R. J. Miller. 1975. Current status of the leopard darter, Percina pantherina. Southwestern Naturalist 20:343-354.

Griffith, B., J. M. Scott, J. W. Carpenter, and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science 245:477-480.

Hubbs, C., and J. Pigg. 1976. The effects of impoundments on threatened fishes of Oklahoma. Proceedings Oklahoma Academy Sciences 5:113-117.

Hubbs, C. L., and A. I. Ortenburger. 1929. Fishes collected in Oklahoma and Arkansas in 1927. Publications of the University of Oklahoma Biological Survey 1:47-105.

James, P. W. 1989. Reproductive ecology and habitat preference of the leopard darter, Percina pantherina. Unpublished Ph.D. dissertation, Oklahoma State University, Stillwater, Oklahoma. 169 pp.

James, P. W., and O. E. Maughan. 1989. Spawning behavior and habitat of the threatened leopard darter, Percina pantherina. Southwestern Naturalist 34:298-301.

James, P. W., O. E. Maughan, and A. V. Zale. 1991. Life history of the leopard darter, Percina pantherina, in Glover River, Oklahoma. American Midland Naturalist 125:173-179.

Jones, R. N. 1984. Recovery Plan for the Leopard Darter (Percina pantherina Moore and Reeves). U.S. Fish and Wildlife Service, Albuquerque, NM. 70 pp.

Jones, R. N., O. E. Maughan, H. W. Robison, and R. J. Miller. 1983. The leopard darter, Percina pantherina: status of populations in Glover Creek, McCurtain County, Oklahoma and Cossatot River, Arkansas. End. Species Rept. No. 12. U. S. Fish and Wildlife Service, Albuquerque, NM. 68 pp.

Jones, R. N., D. J. Orth, and O. E. Maughan. 1984. Abundance and preferred habitat of the leopard darter, Percina pantherina, in Glover Creek, Oklahoma. Copeia 1984:378-384.

Jones, R. N., and O. E. Maughan. 1987. Food of two species of darters in Glover River, Oklahoma. Proceedings Oklahoma Acadamy Sciences 67:73-74.

Kuehne, R. A., and R. W. Barbour. 1983. The American darters. University Press of Kentucky, Lexington, KY. 177 pp.

Lechner, M., A. V. Zale, S. O'Donnell, and B. Ben. 1987. Distribution and abundances of the leopard darter, Percina pantherina (Moore and Reeves), in the upper Mountain Fork and upper Little River drainages. Final Report, U. S. Army Corps of Engineers, Tulsa, OK. 27 pp.

Leon, S. C., M. T. Ferguson, O. E. Maughan, and A. V. Zale. 1987. Distribution and abundances of the leopard darter, Percina pantherina (Moore and Reeves). Final Report, U. S. Army Corps of Engineers, Tulsa, OK. 34 pp.

Maughan, O. E., S. Burks, A. Echelle, R. N. Jones, A. R. Rutherford, S. Adams, K. Collins, J. Matlock, and R. Collins. 1983. Impact of timber harvest activities on aquatic life in southeastern Oklahoma streams. Draft Completion Report, Okla. State Univ., Stillwater. 344 pp.

Miller, R. J., and H. W. Robison. 1973. The fishes of Oklahoma. Okla. State Univ. Press, Stillwater, OK. 246 pp.

Moore, G. A., and J. D. Reeves. 1955. Hadropterus pantherinus, a new percid fish from Oklahoma and Arkansas. Copeia 1955:89-92.

Page, L. M. 1983. Handbook of darters. TFH Publications, Neptune City, NJ. 271 pp.

Robison, H. W. 1978. The leopard darter (a status report). Endangered Species Report No. 3, U. S. Fish and Wildlife Service, Albuquerque, NM. 28 pp.

Robison, H. W., G. A. Moore, and R. J. Miller. 1974. Threatened fishes of Oklahoma. Proceedings Oklahoma Acadamy Sciences 54:139-146.

U. S. Army Corps of Engineers. 1975. Environmental statement, Lukfata Lake, Glover Creek, Oklahoma. U. S. Army Corps of Engineers, Tulsa District, Tulsa, OK. 145 pp.

U. S. Fish and Wildlife Service. 1979. Memorandum from James E. Johnson to Eugene Maughan.

U. S. Fish and Wildlife Service. 1985. Letter from M. J. Spear, Regional Director to Col. Franklin Tilton, District Engineer, U. S. Army, Corps of Engineers, Tulsa District. Albuquerque, NM. 14 pp.

Williams, J. E., D. W. Sada, C. D. Williams, J. R. Bennett, J. E. Johnson, P. C. Marsh, D. E. McAllister, E. P. Pister, R. D. Radant, J. N. Rinne, M. D. Stone, L. Ulmer, and D. L. Withers. 1988. American Fisheries Society guidelines for introductions of threatened and endangered fishes. Fisheries 13(5):5-11.

PART III: IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and estimated costs for the leopard darter recovery program. It is a guide for meeting objectives of this plan, as elaborated upon in Part II: Recovery. This table indicates the priority in scheduling tasks to meet the objectives, which parties will be involved in the completion of the tasks, and a timetable for accomplishing the tasks. These tasks, when accomplished, should bring about recovery of the species and protection of its habitat. The estimated monetary needs for all parties involved are identified and, therefore, Part III reflects the total estimated financial requirements for the recovery of this species.

Definitions

Priorities in column 1 of the following table are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2 - An action that must be taken to prevent a significant decline in species population, habitat quality, or some other significant negative impact short of extinction.

3. Priority 3 - All other actions necessary to meet recovery objectives.

Ongoing tasks are those which are presently being implemented and should be continued as needed.

Continuous tasks are those which require frequent action and should be continued until the leopard darter is recovered.

Key to acronyms used in the Implementation Schedule

Region - FWS Regional Office: 2 - Albuquerque, 4 - Atlanta, 8 - Research

Federal Agencies

COE - Corps of Engineers
EPA - Environmental Protection Agency
FS - Forest Service
FHWA-Federal Highway Administration
FWS- Fish and Wildlife Service
CRU - Cooperative Research Unit
EN - Engineering
FH - Fish Hatcheries
FWE - Fish and Wildlife Enhancement
LE - Law Enforcement
PA - Public Affairs
RE - Realty
RF - Refuges and Wildlife
WM - Water Management

State and Private Parties

ADPT-Arkansas Department of Parks and Tourism: The ADPT develops, maintains, and operates Arkansas State Parks, including providing interpretive programs at these parks.

AGF-Arkansas Game and Fish Commission: the mission of the AGF is to manage the state's fish and wildlife resources.

APC-Arkansas Department of Pollution Control and Ecology: The APC is responsible for the prevention, abatement, and control of all types of pollution and for maintaining the state's natural environment.

OCC-Oklahoma Conservation Commission: the OCC has no regulatory power. This State agency primarily provides technical assistance and information to private landowners and oversees state cost-sharing programs for approved soil and water management practices. The OCC maintains a list of Best Management Practices recommended for controlling contamination of surface and ground water from agricultural activities.

ODA-Oklahoma Department of Agriculture: one of the roles of the ODA is to insure that agricultural production does not harm the environment. ODA regulates the labelling, classification, licensing, application and damage from the use of pesticides. The ODA enforces the Oklahoma Feed Yard Act which relates to the protection of water from contamination arising from improper disposal or handling of animal wastes. The ODA also has the principal responsibility for designing best management practices for the protection of ground and surface water from the impacts of forestry.

ODOT-Oklahoma Department of Transportation: ODOT is responsible for the construction and maintenance of the state's highway system. The ODOT maintains considerable expertise in the design and construction of bridges and similar structures.

ODWC-Oklahoma Department of Wildlife Conservation: ODWC is responsible for the management, use, and protection of the state's fish and wildlife resources.

ONHI-Oklahoma Natural Heritage Inventory: ONHI is under the jurisdiction of the Oklahoma Biological Survey. The Survey is responsible for acquiring information on biological resources and natural areas and conducts research on natural biota.

OTRC-Oklahoma Tourism and Recreation Commission: OTRC is responsible for the administration of the state's park, lodge and tourism programs. They function to promote, among other things, wildlife preservation and environmental conservation.

OSRC-Oklahoma Scenic Rivers Commission: the OSRC was established for the purpose of developing the state's scenic river areas and adjacent contiguous lands and to administer a resource management program for the designated areas.

OWRB-Oklahoma Water Resources Board: the OWRB has the responsibility for developing comprehensive programs designed to prevent, control, and abate pollution of waters of the state. This includes issuing permits for water withdrawals and industrial discharges.

TNC-The Nature Conservancy: TNC is a private, non-profit organization whose mission is to preserve plants, animals, and natural communities by protecting the lands and water they need to survive.

WEYER-Weyerhaeuser Company: the principal private landholder within the Little River basin.

RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY FWS REGION	FWS PROGRAM	OTHER	COST ESTIMATES ($000) FY 1	FY 2	FY 3	COMMENTS
1	1.1	Deauthorize Lukfata Reservoir	8.0 years	2	FWE		?	?	?	Requires Congressional action
						COE	?	?	?	
1	1.21	Glover River Protection Plan	3.5 years	2	FWE*		5	5	5	
					RF		5	5	5	
					RE		1	1	1	
						COE	10	10	10	
						EPA	10	10	10	
						FS	1	1	1	
						ODWC	5	5	5	
						OCC	2	2	2	
						ODA	2	2	2	
						OSRC	1	1	1	
						WEYER	2	2	2	
1	3.1	Determine Genetic Variation	2.0 years	2,4	FWE*		3	3	0	Cost includes tissue collection & analysis of 50 fish/major tributary
					FH		1	1	0	
				8	CRU		1	1	0	
2	1.22	Land Ownership Map	1.5 years	2,4	RE		0	2	2	
						ODWC	0	1	1	
						AGF	0	1	1	
						WEYER	0	1	1	
						TNC	0	1	1	
2	1.231	Private Sector Habitat Protection - Upper Little River	2.0 years	2	FWE		8	8	0	
						EPA	5	5	0	
						ODA	2	2	0	
						ODWC	1	1	0	
						WEYER	1	1	0	
						TNC	1	1	0	
2	1.232	Private Sector Habitat Protection - Robinson Fork River	1.0 years	4	FWE		4	0	0	
						AGF	3	0	0	
						WEYER	2	0	0	
						TNC	2	0	0	
2	1.233	Private Sector Habitat Protection - Upper Mountain Fork River	2.0 years	2,4	FWE		0	10	10	
						EPA	0	8	8	
						ODWC	0	2	2	
						ODA	0	1	1	
						OCC	0	1	1	
						AGF	0	2	2	
						WEYER	0	1	1	
						TNC	0	1	1	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY FWS REGION	FWS PROGRAM	OTHER	COST ESTIMATES ($000) FY 1	FY 2	FY 3	COMMENTS
2	1.234	Private Sector Habitat Protection - Tributaries	3.0 years	2	FWE		0	12	12	
						EPA	0	5	5	
						ODWC	0	3	3	
						ODA	0	1	1	
						OCC	0	1	1	
						WEYER	0	1	1	
						TNC	0	1	1	
2	1.24	Complete Habitat Protection	5.0 years	2,4	FWE		?	?	?	Not needed if private protection actions are successful
					RF*		?	?	?	
					RE		?	?	?	
						COE	?	?	?	
						FS	?	?	?	
						ODWC	?	?	?	
						OTRC	?	?	?	
						TNC	?	?	?	
2	1.251	Point Source Discharges	Continuous	2,4	FWE		7	7	7	
						EPA	3	3	3	
						OWRB	6	6	6	
						ODWC	1	1	1	
						APC	2	2	2	
						AGF	1	1	1	
2	1.252	Non-point Source Discharges	Continuous	2,4	FWE		5	5	5	
						EPA	2	2	2	
						OWRB	2	2	2	
						OCC	3	3	3	
						ODA	3	3	3	
						ODWC	1	1	1	
						APC	2	2	2	
						AGF	1	1	1	
2	1.261	Monitor clearcutting	Continuous	2,4	FWE*		2	1	2	Includes biennial over-flights
					RF		1	0	1	
					LE		0	2	0	
						COE	2	2	2	
						EPA	2	2	2	
						ODA	4	4	4	
						ODWC	2	2	2	
						OCC	2	2	2	
						APC	1	1	1	
						AGF	2	2	2	
						WEYER	3	3	3	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY FWS REGION	FWS PROGRAM	OTHER	COST ESTIMATES ($000) FY 1	FY 2	FY 3	COMMENTS
2	1.262	Evaluate Poultry And Swine Operations	5.0 years	2,4	FWE		1	1	1	Includes biennial over-flights
						EPA	1	1	1	
						ODA	5	5	5	
						OCC	5	5	5	
						ODWC	1	1	1	
						APC	1	1	1	
						AGF	1	1	1	
2	1.2621	Determine Location, Number, Ownership, And Production Of Poultry And Swine Operations	2.5 years	2,4	FWE		0	0	1	
						ODA	2	2	0	
						OCC	2	2	0	
						APC	1	1	0	
2	1.2622	Landowner Contact And Assistance Program	2.0 years	2,4	FWE*		2	2	0	
					LE		1	1	0	
						ODA	2	2	0	
						OCC	4	4	0	
						ODWC	1	1	0	
						APC	1	1	0	
						AGF	1	1	0	
2	1.263	Assess Impacts Of Existing Stream Crossings	3.0 years	2,4	FWE*		2	2	2	
					EN		1	1	1	
				8	CRU		1	1	1	
						COE	2	2	2	
						FS	1	1	1	
						FHWA	0	1	1	
						ODOT	0	1	1	
						WEYER	1	1	1	
2	1.264	Monitor Compliance With Pesticide Use Restrictions	Continuous	2,4	FWE*		2	2	2	
					RF		1	0	1	
					LE		1	1	1	
						EPA	2	2	2	
						ODA	3	3	3	
2	2.1	Determine Extent Of Suitable Habitat	2.5 years	2,4	FWE*		6	6	3	
				8	CRU		2	2	1	
						ODWC	2	2	1	
						ONHI	2	2	1	
						AGF	1	1	0	
2	2.2	Determine Movement And Survivorship Patterns	3.0 years	2,4	FWE*		6	6	6	
				8	CRU		2	2	2	
						ONHI	1	1	1	
						ODWC	1	1	1	
						AGF	2	2	2	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY FWS REGION	FWS PROGRAM	OTHER	COST ESTIMATES ($000) FY 1	FY 2	FY 3	COMMENTS
2	2.3	Permanent Monitoring	Continuous	2,4	FWE		2	2	2	
						FS	1	1	1	
						ODWC	2	2	2	
						AGF	1	1	1	
2	2.4	Assess Importance Of Small Tributaries As Spawning Sites	2.0 years	2,4	FWE*		0	3	3	
				8	CRU		0	2	2	
						ODWC	0	1	1	
						ONHI	0	1	1	
						AGF	0	1	1	
2	3.2	Determine Minimum Viable Population Size	Unknown	2,4	FWE*		0	0	6	
				8	CRU		0	0	2	
						ONHI	0	0	1	
						ODWC	0	0	1	
						AGF	0	0	1	
2	4.1	Complete Brochure	Ongoing	2,4	FWE*		2	0	0	Cost reflects only the initial printing
					PA		1	1	0	
						ODWC	1	1	0	
2	4.2	Erect Displays	2.5 years	2,4	FWE*		1	1	2	
					RF		0	2	0	
						COE	5	5	0	
						ODWC	1	1	0	
						ODOT	2	2	0	
						AGF	3	3	0	
						ADPT	2	0	0	
2	5.1	Re-establish Populations In Cossatot And Robinson Fork Rivers	5.0 years	4,2	FWE		4	4	4	
						AGF	4	4	4	
						WEYER	2	2	0	
3	1.2623	Prepare Habitat Conservation Plan	3.0 years	2,4	FWE		0	0	2	Will not be initiated unless needed
						EPA	0	0	1	
						ODA	0	0	1	
						OCC	0	0	1	
						ODWC	0	0	1	
						AGF	0	0	1	
						APC	0	0	1	
3	1.265	Determine Magnitude Of Threat From Acid Precipitation	5.0 years	2,4	FWE		0	0	3	
						EPA	0	0	3	

RECOVERY PLAN IMPLEMENTATION SCHEDULE (Continued)

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY FWS REGION	FWS PROGRAM	OTHER	COST ESTIMATES ($000) FY 1	FY 2	FY 3	COMMENTS
3	2.5	Determine Distribution, Abundance, And Extent Of Habitat On Ouachita National Forest	1.0 years	2,4	FWE		2	0	0	
						FS	4	0	0	
3	5.2	Initiate Habitat Enhancement Projects	Unknown	2,4	FWE		0	0	2	
						COE	0	0	1	
						OCC	0	0	1	
						OWRB	0	0	1	
						ODWC	0	0	1	
						AGF	0	0	1	
3	5.3	Re-establish Populations Downstream Of Gillham Reservoir	Unknown	4,2	FWE*		0	0	?	
					WM		0	0	?	
						COE	0	0	?	
						AGF	0	0	?	
3	6	Develop Monitoring Plan	6.0 years	2,4	FWE		0	0	0	Task duration includes plan implementation
						ODWC	0	0	0	
						AGF	0	0	0	